

Potential Moderators of the Effects of a School-Based Mindfulness Program on Symptoms of Depression in Adolescents

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Abstract An essential step to wide-scale dissemination is to investigate moderators of intervention effectiveness. This study examined moderators of the effects of a universal school-based mindfulness program on adolescents' depressive symptoms. Based on theory and previous research, we identified the following potential moderators: (1) severity of symptoms of depression at baseline, (2) gender, (3) age, and (4) school track. The study uses a pooled dataset from two consecutive randomized controlled trials in adolescents (13–18 years) in secondary schools in Belgium. Results on effectiveness based on the first trial were published in this journal (Raes et al. 2014). A second consecutive trial was conducted to obtain a more equal distribution between school tracks and to enlarge power, yielding a total of 605 students from nine schools. In each school, parallel classes were randomized to the mindfulness condition or usual curriculum control condition. Data were collected 1 week before and 1 week after delivery of the training and at 6-month follow-up. Moderation was tested longitudinally with multilevel models across the three repeated measures and across condition. We found no moderation effects of gender, age, and school track. Six months after the training, we found a marginally significant moderation effect for severity of symptoms of depression at baseline with greater decrease in symptoms for students with high levels of depression. The general absence of differential intervention effects for gender, age, and school track supports the broad scope of the school-based mindfulness group intervention.

Keywords Mindfulness · Depression · Prevention · Moderators · Adolescents · Schools

Introduction

Depression is one of the most prevalent emotional problems experienced by adolescents and may lead to emotional disorders in adulthood (Kessler et al. 2007; Patton et al. 2014). Therefore, the need for effective prevention programs that can be widely implemented is high. Mindfulness-based programs for adolescents are becoming very popular in this context.

Mindfulness refers to a compassionate and non-judgmental moment-to-moment awareness of one's experiences (Kabat-Zinn 1990). Mindfulness interventions are theorized to target emotion and cognition regulation, key processes in mental well-being in general and more specifically in depression. In a recent study with clinically depressed youth, greater dispositional mindfulness predicted greater recovery from depression (Chambers et al. 2015). Pearson et al. (2015) found a sharp contrast in emotional functioning between subgroups of college students distinguished based on their mindfulness scores, with the high mindfulness group having the most adaptive emotional outcomes (e.g., lower depressive symptoms). Reviews and meta-analyses on the effect of mindfulness-based interventions for youth show positive findings which are consistent with those reported in adult populations (Zoogman et al. 2015; Kallapiran et al. 2015). A recent review also shows that it can be successfully used as an intervention to reduce stress, anxiety, and depression and promote general mental well-being in a school context (Zenner et al. 2014; but see Johnson et al. 2016, for a recent non-replication).

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Testing the efficacy of interventions especially in natural environments such as schools is an essential step to wide-scale dissemination. Studies on mindfulness-based interventions with adolescents have predominantly been outcome-based to understand the efficacy and effectiveness of the programs, with less focus on possible moderators. It is also essential, however, to investigate potential moderators as effectiveness can vary considerably depending on individual, demographic, and environmental factors. Investigating moderators is important for several reasons. It helps to identify subgroups of individuals most likely to benefit from the intervention and can determine subgroups of individuals unlikely to benefit from the prevention program and who may require adapted, adjunctive, or alternative approaches (Kraemer et al. 2002). On the other hand, knowing that a prevention program is similarly effective for a wide variety of individuals would imply that it can be easily and broadly disseminated. Therefore, a moderation analysis can provide essential information to use in defining guidelines for successful and cost-effective dissemination of programs in mental health promotion.

Based on theory and previous research on depression prevention programs, potential moderator variables are severity of symptoms at baseline, gender, and age (Horowitz and Garber 2006; Stice et al. 2009). In case of elevated symptoms, there is more room for improvement and participants with elevated symptoms can be more motivated to apply the learned intervention skills to address current symptoms (Brière et al. 2014). Concerning the demographic factors, meta-analyses indicate that girls might benefit more from universal school-based depression prevention programs than boys (Horowitz and Garber 2006). This pattern of effect is due to the fact that girls report greater symptoms of depression which can make it easier to detect intervention effects (Hankin et al. 1998; Castelao and Kroener-Herwig 2013). With regard to age, previous trials with cognitive-behavioral therapy (CBT) tend to show better effects in older adolescents (McCart et al. 2006; Stice et al. 2009). As youth age and develop cognitively, they may receive added benefits from cognitive-behavioral skills.

To date, few single studies have investigated factors that moderate the effects of different school-based depression prevention programs for adolescents (e.g., Brière et al. 2014). Brière et al. (2014) investigated moderators of two indicated prevention approaches with adolescents experiencing elevated symptoms of depression. They found no moderation effects in the cognitive-behavioral group-based prevention condition. Elevated baseline depressive symptoms amplified the effect in the cognitive-behavioral bibliotherapy group. The study population was a self-selected sample with highly motivated participants.

To our knowledge, only one study has examined moderators of intervention response to a school-based mindfulness program (Gould et al. 2012). They examined gender, grade

level, and baseline depressive symptoms as potential moderators of a school-based mindfulness intervention's impact on self-regulatory outcomes of urban youth. Gender and grade did not moderate intervention impact. Baseline depressive symptoms moderated both impulsive action and involuntary engagement stress responses. Students in the mindfulness condition, characterized by lower levels of baseline depressive symptoms, were more likely to evidence decreases in these problematic stress responses relative to control youth. A crucial limitation of this study was the small sample size ($N = 79$) which did not permit an accurate test of moderation.

The present study aims to advance our knowledge on potential moderators of the effect of a school-based mindfulness intervention for adolescents. More specifically, we examine moderators of the effects of a school-based mindfulness program, relative to a control condition where the students followed their regular school program. To allow an adequately powered evaluation of moderators and a comparison between general education and technical and vocational school tracks, this study uses data from an earlier efficacy trial (Raes et al. 2014) conducted in a first phase of the study (school years 2009–2010 and 2010–2011) and a second smaller randomized controlled trial conducted in a second phase (school year 2011–2012). The study was conducted in secondary schools located in Flanders (the northern part of Belgium). In the Belgium school system, students can choose between general education (theoretical focus, preparing students for higher education), technical education (less theoretical focus with a more technical and practical approach, preparing students for higher education or the job market), and vocational education (i.e., practical and job-specific education). Since general education schools were overrepresented in our first trial, we included more technical and vocational schools during the second phase in order to obtain a more equal distribution between the different school tracks. Results of the first trial showed that the school-based mindfulness program was successful at significantly reducing symptoms of depression compared to control with an overall medium effect size (Raes et al. 2014). We extend our findings of these promising results in the current study with an adequately powered moderation analysis. Three potential primary moderator variables were identified a priori: severity of symptoms at baseline, gender, and age. We hypothesized that individuals with a greater severity of depressive symptoms at baseline would have better outcomes in the intervention condition. We also hypothesized that girls would have better outcomes than boys and expected larger effects for older compared to younger adolescents. Finally, school track (vocational vs. technical vs. general education) was explored as a secondary moderator variable representing school environment. Beyond this moderation analysis, we also wanted to know whether the overall effect on symptoms of depression maintained when including more vocational and technical schools.

Method

Participants

The first phase study included 408 participants, 201 in the mindfulness condition and 207 in the control condition. The second phase study included another 197 participants, 96 students in the mindfulness (MFS) condition and 101 students in the control condition. The current study is based on the combined sample of 605 students, 297 in the MFS condition and 308 in the control condition. Participants who completed only T1 were omitted from the dataset, and the analysis is based on a sample of 553 students. Failure to complete all questionnaires was mainly because of absences from school when data collection took place. Participants were between 13 and 20 years old ($M = 15.42$; $SD = 1.14$); 70% were female. Informed consent was received from all students. The ethical committee of the University of Leuven approved the study.

Procedure

In the present study, we combine data collected in two separate study phases. The first phase was conducted in the school years 2009–2010 and 2010–2011 and examined the efficacy of a school-based mindfulness program aimed at reducing and preventing depression in an adolescent population (Raes et al. 2014). A detailed description of the study procedure is given in Raes et al. (2014). Exactly the same procedure, but now with a focus on vocational and technical schools, was followed in the second phase, which was conducted in the school year 2011–2012. This resulted in another five schools participating. Each school offered one or two pairs of parallel classes. In short, one class was randomized to the mindfulness condition and the other to the control (no intervention) condition. The mindfulness program consisted of eight 100 min. Weekly sessions delivered during school hours. No intervention was provided in the control condition. For a more detailed description of the procedure, we refer to Raes et al. (2014). In one vocational school, the mindfulness training was stopped early due to unexpected unavailability of the trainer. Data were collected during class at school, 1 week before and 1 week after delivery of the program, as well as 6 months after the program was completed (see Fig. 1 for flowchart). Mindfulness and control groups completed the questionnaire at the same times.

Intervention The mindfulness group program consisted of eight weekly 100-min sessions and integrated elements of mindfulness-based stress reduction (MBSR; Kabat-Zinn 1990) and mindfulness-based cognitive therapy (MBCT; Segal et al. 2002). A detailed description of the program is given in Raes et al. (2014). Students develop specific skills in their capacity to become non-judgmentally aware of thoughts,

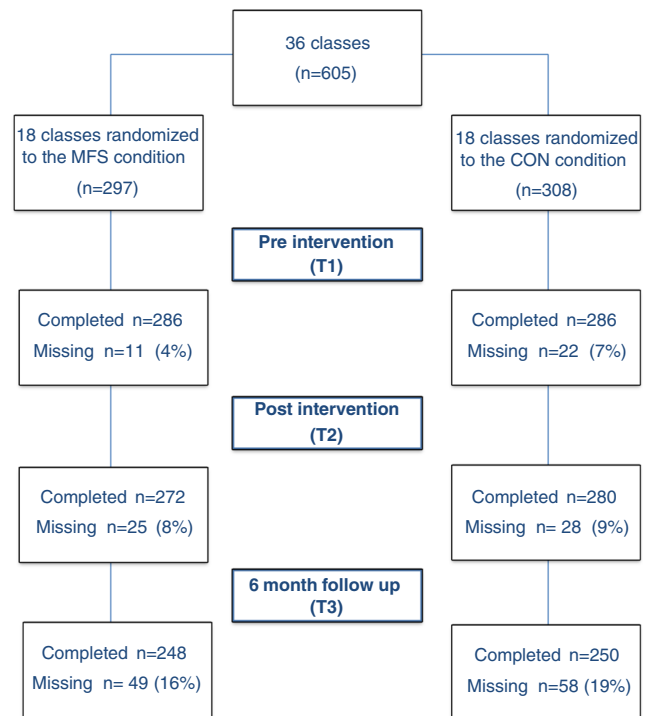


Fig. 1 Flowchart of the recruitment and retention of participants in the combined dataset

feelings, and sensations and increase their capacity to replace automatic, habitual, and often judgmental reactions with more conscious and skillful responses. The program was delivered by certified mindfulness trainers with more than 3-year experience. Two of them were clinical psychologists, and one was a medical doctor. They all worked at the Institute for Attention and Mindfulness (IAM). During the course of the program, they regularly met to evaluate protocol adherence. Competence and/or fidelity was not formally measured.

Measures

Students provided information regarding their gender and age. Depression symptoms were assessed with Depression subscale of the 21-item Depression Anxiety and Stress Scale (DASS-21) (Lovibond and Lovibond 1995), a widely used measure inquiring about the presence of different depression symptoms in the past 7 days. Items are scored on a four-point scale ranging from 0 (*did not apply to me at all*) to 3 (*applied to me very much or most of the time*). Good psychometric properties are reported for the original as well as the Dutch version that we used (Beurs et al. 2001; Willemsen et al. 2011). Internal consistency of the measure in the current sample was good ($\alpha > 0.80$ across all time points). The DASS is quite different from diagnostic instruments in that it reflects the underlying continuity of severity of symptoms in the population. The scale was developed to maximize discrimination between self-reported anxiety and depression while assessing

the full range of these disorders' core symptoms. It has proven to be very useful in community samples and adolescents and is easy to administer (Crawford et al. 2011; Antony et al. 1998; Henry and Crawford 2005; Willemsen et al. 2011).

Data Analyses

The *intervention effect* was tested using a multilevel model with three levels: Time points (level 1) were nested within persons, and persons (level 2) were nested within school (level 3). First, we estimated the “null model,” in which no predictors were included in predicting the outcome variable, depressive symptoms. The null model provides intraclass correlations, which reflect the amount of variance that can be explained by each level. Second, we estimated the “condition model,” in which (a) the dummy-coded assessment time (as a level 1 variable), (b) the treatment condition (as a level 2 variable), and (c) their cross-level interactions were included in predicting depressive symptoms. The level 1 model is as follows:

$$Y_{ijk} = \beta_{0jk} + \beta_{1jk} \times T2 + \beta_{2jk} \times T3 + r_{ijk}$$

The outcome Y_{ijk} represents the level of depression of the j th participant of the k th school at the i th assessment time. The assessment times were coded by two dummy variables, T2 and T3, with 1 indicating the post-treatment (T2) or follow-up assessment (T3). The residual was represented by r_{ijk} . The level 1 intercept (β_{0jk}) and slopes for T2 and T3 (β_{1jk} , β_{2jk}) were allowed to vary randomly across persons at level 2, and their associations with condition were modeled as follows:

$$\beta_{0jk} = \beta_{00k} + \beta_{01k} \times \text{Condition}_{jk} + u_{0jk}$$

$$\beta_{1jk} = \beta_{10k} + \beta_{11k} \times \text{Condition}_{jk} + u_{1jk}$$

$$\beta_{2jk} = \beta_{20k} + \beta_{21k} \times \text{Condition}_{jk} + u_{2jk}$$

Condition was a dummy variable to represent the intervention (1) and control (0) conditions. The random effects (u_{0jk} , u_{1jk} , and u_{2jk}) were used to model individual differences that cannot be explained by the condition differences. Furthermore, we assumed that the intercept (β_{00k}), main effects (β_{01k} , β_{10k} , β_{20k}), and cross-level interactions between the time and condition (β_{11k} , β_{21k}) would vary across different schools. In the level 3 model, each of these six parameters was represented by a fixed and random effect.

The *moderation of intervention effect* was tested by adding potential moderators and their interactions with condition and time to the condition model. This allows to examine whether these factors impacted the magnitude of intervention effects on outcome change. For each potential moderator, we estimated a separate model. Continuous moderators (age and baseline levels of depressive symptoms) were grand-mean centered, whereas gender differences were dummy-coded (male = 0;

female = 1) in the moderation analyses. The “lme4” package (Bates et al. 2015) in R (R Development Core Team 2007) was used for the multilevel analysis.

Further, we calculated between group effect sizes using Cohen's d statistic (Cohen 1988). Finally, we calculated a change index for both intervention and control group to see what percent improved and what percent stayed the same. A two-sample test for equality of proportions was used to detect significant differences between the MFS and control condition.

Results

Descriptive statistics at baseline and correlations among variables of interest are shown in Table 1. Age was uncorrelated with initial symptoms of depression. Girls scored significantly higher on symptoms of depression. Participants in the two conditions did not differ on demographics or any of the study variables at baseline. Table 2 presents the detailed descriptive statistics of the outcome for the two conditions at the three study data collection points.

Intervention Effects

The amount of variance in depression explained at the student level was 0.41, and the amount of variance explained at the school level was 0.06. Comparing the MFS group with the control group, condition \times time had significant effects at T2 on depression severity (estimate = -1.15 , $p = 0.001$) and T3 (estimate = -1.02 , $p = 0.01$). The effect at both time points was negative, which translates into a decrease in depressive symptoms for the MFS group compared to no change in the control group. This suggests that participants in the MFS group, unlike those from the control group, experienced a clear symptom reduction 1 week after the training (T2) and during follow-up (T3). Based on the calculation of Cohen's d between group effect sizes, both of these findings were small to moderate effects (0.38 at T2 and 0.36 at T3). Results of intervention effects on depression scores are shown in Table 3 and Fig. 2.

The percentage of students with a score within the normal range (i.e., ≤ 4) at baseline (see Table 4) did not change within the control group, while in the MFS condition, it was raised with 15%, which is a significant difference ($\chi^2 = 10.61$, $df = 1$, $p = 0.001$). In the MFS condition, 87% of these students (with scores within the normal range at baseline) stayed within the normal range 1 week after the intervention (T2) and 81% at follow-up (T3) versus 74% (T2) and 73% (T3) in the control condition. This difference was only significant 1 week after the intervention ($\chi^2 = 6.66$, $df = 1$, $p = 0.009$). Looking at the number of students with scores at baseline > 4 (mild to extremely severe symptoms of depression), we found that in

Table 1 Descriptive statistics and correlations among variables at baseline (*N* = 553)

	Range	<i>M</i> (SD)	Gender	Age	DASS-D
Gender	0 = ♂ 1 = ♀		1.0		
Age	13–20	15.42 (1.14)	0.06	1.0	
DASS-D	0–21	4.65 (4.04)	0.09*	−0.00	1.0

SD standard deviation

**p* < 0.05

the MFS condition, 47% improved and scored within the normal range 1 week after the intervention (T2) and 61% at follow-up (T3) versus 32% (T2) and 36% (T3) in the control condition. This difference was marginally significant at T2 ($\chi^2 = 3.64$, *df* = 1, *p* value = 0.056) and significant at T3 ($\chi^2 = 10.13$, *df* = 1, *p* value = 0.001).

Moderation of Intervention Effects

One significant and one marginally significant three-way interaction were found for the MFS group compared to the control group. Results are presented in Table 5. A significant interaction effect was found for age at T2, suggesting greater decrease in symptoms for older students. This interaction effect is mainly however due to the difference in symptom scores in the control group, where students older than 15 showed an increase in symptoms at T2, as illustrated in Table 6. A marginally significant negative interaction effect was found for baseline depressive symptoms at follow-up, suggesting greater decrease in symptoms during the 6-month follow-up for students with high levels of depression at baseline. At T2, the differences in declining trend between participants with high and low depressive symptoms at baseline can be explained only by accumulation of the main effects of condition (true treatment effect) and time (natural recovery or regression to the mean) (see Table 7). No significant interaction effects were found for gender or school track.

Table 2 Descriptive statistics of outcomes for the two conditions at the three study data collection points

	MFS		Control	
	<i>M</i> (SD)	<i>n</i>	<i>M</i> (SD)	<i>n</i>
DASS-D-T1	4.47 (3.91)	286	4.82 (4.11)	287
DASS-D-T2	3.37 (3.40)	280	4.87 (4.49)	272
DASS-D-T3	3.17 (4.01)	250	4.72 (4.57)	248

Table 3 Results of multilevel model estimating intervention effect on depressive symptoms piecewise at T2 and T3

	Est. (SE)	<i>t</i>	<i>p</i>
Intercept	4.81 (0.32)	15.04	<0.001
T2	0.06 (0.27)	0.23	0.821
T3	−0.11 (0.38)	−0.29	0.775
Condition	−0.33 (0.38)	−0.87	0.401
T2:condition	−1.15 (0.35)	−3.31	0.001
T3:condition	−1.02 (0.40)	−2.53	0.012

SE standard error

Discussion

The aim of this study was to identify factors that moderate the effects on symptoms of depression of a mindfulness group intervention relative to a no-intervention control condition in a school-based cluster randomized trial. The results are based on a pooled dataset using data from an earlier efficacy trial (Raes et al. 2014) and new data focusing on technical and vocational schools. The overall effect on symptoms of depression, as shown in the first phase where mainly general education schools were included, remained significant. The program was found to be effective in reducing symptoms of depression post-intervention and at 6-month follow-up. Effect sizes were small (0.38 post-intervention and 0.36 at follow-up). These effect sizes are in line with effects found in prior studies examining the efficacy of universal school-based cognitive-behavioral programs for preventing depressive symptoms (e.g., Poessel et al. 2013; Horowitz et al. 2007) and with results reported in recent reviews and meta-analyses on prevention of depression in adolescents (Ahlen et al. 2015; Stockings et al. 2016).

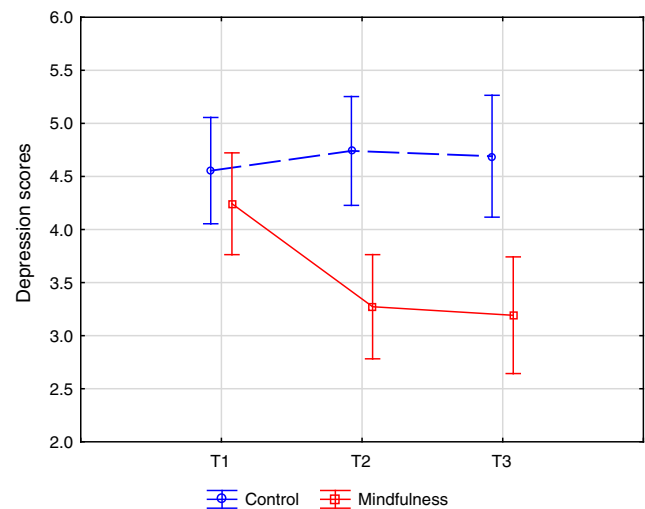


Fig. 2 Depression scores measured with the DASS-21 subscale for depression over T1 (baseline), T2 (post-treatment), and T3 (follow-up)

Table 4 Number and percentage of students scoring within the normal range for depression symptoms at baseline, 1 week after the intervention, and follow-up

Condition	T1		T2		T3	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
All—score ≤4 at T1, T2, and T3						
Control (<i>n</i> = 216)	125	58	121	56*	124	57*
Mindfulness (<i>n</i> = 236)	144	61	168	71	173	73
Only those with score ≤4 at T1 and ≤4 at T1 and at T3						
Control	125	58	92	74*	91	73
Mindfulness	144	61	125	87	117	81
>4 at T1; ≤4 at T2 and at T3; >4 at T1						
Control	91	42	29	32*	33	36*
Mindfulness	92	39	43	47	56	61

**p* < 0.05 for difference between mindfulness versus control group

These small effects are typical for universal preventive intervention studies that involve predominantly healthy participants and seek to detect differences in the movement of symptom scores away from the mean (Nehmy 2010; Nehmy and Wade 2015). Therefore, although the effect sizes are small, they are highly relevant in demonstrating that a non-indicated, low-threshold, school-based mindfulness intervention positively affects adolescents' depressive symptoms. Ahlen et al. (2015) report on the practical and clinical importance of such seemingly trivial effect sizes in universal studies.

Further, in the mindfulness condition, a significantly larger percentage of students (15%) scored within the normal range of depression symptoms 1 week after the intervention and at

Table 5 Results of multilevel models estimating the condition × time × moderator interaction effect on depressive symptoms piecewise at T2 and T3

	T2			T3		
	Est. (SE)	<i>t</i>	<i>p</i>	Est. (SE)	<i>t</i>	<i>p</i>
Baseline symptoms						
DASS-D	−0.06 (0.08)	−0.73	0.466	−0.17 (0.09)	−1.84	0.065
Gender						
DASS-D	−0.57 (0.79)	−0.72	0.472	−0.69 (0.92)	−0.76	0.451
Age						
DASS-D	−0.82 (0.31)	−2.66	0.008	−0.15 (0.37)	−0.40	0.687
School track—TSO (ASO is reference group)						
DASS-D	−0.49 (0.89)	−0.55	0.583	0.89 (1.03)	0.86	0.389
School track—BSO (ASO is reference group)						
DASS-D	0.92 (0.96)	0.96	0.340	1.69 (1.16)	1.46	0.144

The main fixed effects and interactions are given in Tables 5 and 6

ASO general education, TSO technical education, BSO vocational education

Table 6 Main and interaction effects of multilevel model estimating age as a moderator of the intervention effect on symptoms of depression

	Est. (SE)	<i>t</i>	<i>p</i>
Intercept	4.85 (0.35)	13.83	<0.001
T2	−0.26 (0.29)	−0.91	0.369
T3	−0.27 (0.40)	−0.67	0.512
Condition	−0.52 (0.41)	−1.29	0.224
Age	−0.11 (0.21)	−0.52	0.607
T2:condition	−0.80 (0.37)	−2.16	0.031
T3:condition	−0.95 (0.44)	−2.13	0.050
T2:age	0.75 (0.22)	3.35	<0.001
T3:age	0.38 (0.27)	1.42	0.158
Condition:age	0.44 (0.29)	1.50	0.136
T2:condition:age	−0.82 (0.31)	−2.66	0.008
T3:condition:age	−0.15 (0.37)	−0.40	0.688

follow-up compared to the control condition. This percentage was a combination of a larger number of students who started within the normal range and stayed well (preventive aspect) and a larger number of students with baseline symptoms above the normal range and who ameliorated during the study period (curative aspect).

Another important finding was that the significant positive effect compared with the non-intervention control condition persists at the 6-month follow-up evaluation. In many RCTs with universal prevention programs, effects are often more limited in time with the absence of an enduring effect (Horowitz et al. 2007; Poessel et al. 2013). In the study by Poessel et al. (2013), the positive effect of the cognitive-behavioral program did not persist after the 4-month follow-up evaluation. In the randomized controlled trial by Horowitz et al. (2007), the overall group effects for the cognitive-

Table 7 Main and interaction effects of multilevel model estimating depressive symptoms at baseline as a moderator of the intervention effect on symptoms of depression

	Est. (SE)	<i>t</i>	<i>p</i>
Intercept	4.66 (0.21)	21.91	<0.001
T2	0.14 (0.24)	0.56	0.579
T3	−0.08 (0.25)	−0.34	0.735
Condition	0.01 (0.25)	0.04	0.968
DepT0	0.99 (0.04)	22.39	<0.001
T2:condition	−1.33 (0.03)	−3.89	<0.001
T3:condition	−1.27 (0.04)	−3.61	<0.001
T2:DepT0	−0.45 (0.06)	−7.44	<0.001
T3:DepT0	−0.53 (0.06)	−8.45	<0.001
Condition:DepT0	0.00 (0.06)	0.00	0.997
T2:condition:age	−0.06 (0.08)	−0.73	0.466
T3:condition:age	−0.17 (0.09)	−1.84	0.065

behavioral program and the interpersonal prevention program were not maintained at 6-month follow-up.

As putative moderators, we examined baseline depressive symptoms as an individual moderator, gender and age as two sociodemographic moderators, and school track as a school context measure. We found a marginally significant moderation effect involving baseline depressive symptoms, intervention condition, and time. Elevated baseline depressive symptoms moderated the effect only at follow-up suggesting a greater decrease in depressive symptoms for students with high levels of depressive symptoms at baseline. A possible statistical explanation is that elevated symptoms at baseline may have facilitated the detection of symptom improvements at follow-up by limiting “floor effects.” Another possible explanation is that students experiencing negative emotions and cognitions may be more motivated to continue to apply the learned mindfulness skills. We did not find a moderation effect of baseline symptoms immediately after the intervention. This might be an indication that participants with only mild symptoms experienced positive effects similar to those participants experiencing more severe symptoms at baseline.

Indications that baseline depressive symptoms moderate the effect of depression prevention programs align with evidence from individual studies and meta-analyses showing stronger effects for participants with higher versus lower initial symptoms (Horowitz and Garber 2006; Stice et al. 2009; Mueller et al. 2015). Our findings are also consistent with a recent individual patient data meta-analysis studying the efficacy of MBCT in the prevention of depressive relapse (Kuyken et al. 2016). The authors found no differential effects for patients based on their age, gender, education, or relationship status, suggesting the intervention’s generalizability. There was some evidence, however, to suggest that the treatment effect is larger in participants with higher levels of depressive symptoms at baseline.

We also found a significant effect involving age, intervention condition, and time. However, this effect was mainly due to an increase in depressive symptoms in the control group for students older than 15. Therefore, we cannot conclude that age influenced the intervention outcome. This might be encouraging in that intervention outcomes appear to be unaffected by possible developmental differences. Age was found as a moderator in previous meta-analyses (Stice et al. 2009; Horowitz and Garber 2006).

Although girls did report greater depressive symptoms at baseline, no evidence was found for a moderating effect for gender. Again, gender was found as a moderator in previous meta-analyses (Stice et al. 2009; Horowitz and Garber 2006).

Why our findings differ from the previous *meta-analyses* with regard to the moderating effect of age and gender might also be explained by the fact that our study focuses on a single study. Results from other single studies show indeed mixed results, with several recent studies reporting no difference in

effect for the depression prevention programs in girls and boys (Poessel et al. 2013; Horowitz et al. 2007).

Another possible hypothesis to explain the absence of a moderating effect of gender and age might be found in neuroimaging studies (Wetherill and Tapert 2013; Gard et al. 2012; Sanger and Dorjee 2015). Both cognitive-behavioral therapy and mindfulness-based therapy train individuals to increase self-control and regulate automatic emotional responses by attenuating limbic responses to emotional triggers and enhancing specific top-down modulation processes localized at prefrontal areas (Murakami et al. 2015; Gard et al. 2012). Whereas cognitive-behavioral strategies appear to work mainly through “top-down” prefrontal-limbic circuitry changes, mindfulness-based approaches appear to change emotional reactivity also through “bottom-up” subcortically based changes (Chiesa et al. 2013; Tang et al. 2015). There is some evidence that non-judgmental attention to one’s feelings, sensations may lead to “reduced emotional reactivity” without concurrent activation of modulatory prefrontal cortex regions (e.g., Westbrook et al. 2013; van den Hurk et al. 2010). Given the early development of subcortical circuitry in adolescence relative to cortical (i.e., frontal involved in top-down cognitive control), it is possible that mindfulness-based approaches may be ideal for targeting intermediate phenotypes of affective dysregulation and stress that are characteristic of adolescence. The fact that mindfulness-based approaches work through top-down as well as bottom-up changes might explain the absence of gender and age differences which are often found in studies with cognitive-behavioral therapy. Mindfulness may be especially helpful for adolescents who have highly reactive limbic systems and have a difficult time with increasing cognitive control given that the prefrontal brain regions and circuitry needed for adequate control might not be fully developed or process efficiently (Sanger and Dorjee 2015; Wetherill and Tapert 2013).

Although we could not find an effect of school track in our analyses, informal feedback from the mindfulness trainers and school teachers suggested less feasibility in vocational schools. Mindfulness trainers experienced early resistance, apathy, and discipline problems, especially in the initial sessions. Teachers also reported a high percent of vulnerable and at-risk youth in these schools. This is in agreement with the findings of Bluth et al. (2016) who examined factors impacting on the feasibility of school-based mindfulness interventions with at-risk youth. Our findings suggest that despite these difficulties, facilitators were able to present the intervention to a broad range of adolescents.

The general absence of moderation effects on gender, age, and school track supports the broad preventive scope of the mindfulness intervention and offers evidence of its main universal effect. This is an important finding as universal school-based programs have advantages compared to targeted programs. Universal school-based programs (1) are available to

all students including those currently deemed at lower risk but whose risk profile changes later, (2) might be seen as cost-effective alternatives to afterschool programs and do not face the substantial costs associated with screening, and (3) may help to normalize participation in behavioral interventions, especially when the intervention is not laden with the stigma of mental illness in the common perception.

Strengths and Limitations

The strengths of this study include a large dataset based on two consecutive randomized controlled trials (phase 1 in 2009–2011 (Raes et al. 2014) and phase 2 in 2011–2012), conducted in a real-life context, examining effects over two post-intervention time points (post-test, 6-month follow-up) and covering different school tracks. This provides useful information about real-world effectiveness of the mindfulness intervention.

We used a no-intervention control which did not allow us to conclude that the effect was not due simply to common, non-specific factors (e.g., attention from a supportive adult). Including a non-specific comparison condition that is equivalent in structure and duration should allow to test for evidence of specificity. Future studies should identify what specific components of the mindfulness-based intervention underlie its effectiveness and determine the active processes responsible for the positive effects. We also did not control for “treatment contamination” which might have an impact on effect sizes.

We relied on self-report data from surveys. Future studies should broaden beyond self-report outcome measures to look at biological and biobehavioral parameters, if possible measured in real life.

Although we had a follow-up assessment at 6 months, this is still limited in time to investigate long-term effects. Trials with follow-up periods of 12 months and longer are needed. A recent systematic review of systematic reviews and meta-analyses on effectiveness of interventions to prevent the onset of episodes of depression shows that there is a lack of evidence on long-term effectiveness with only 24% of the trials having a follow-up period longer than 12 months (Bellon et al. 2015). The so far observed general decrease of prevention impact over time in universal prevention programs might be due to a natural decline or stagnation process meaning that repeated exposures to the intervention are necessary to maintain an acceptable level of benefit over time (Stockings et al. 2016). Long-term follow-up studies should evaluate the benefit of booster sessions or supplemental information and reminders delivered by social media.

Due to the fast-growing interest in mindfulness-based approaches, many different intervention formats have emerged and variability is large in both program content and length.

This lack on uniformity is a general concern in research on mindfulness for youth.

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Compliance with Ethical Standards

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Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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